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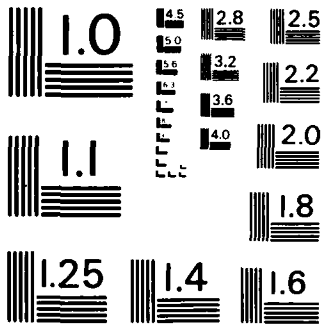

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This report documents the results of the investigatory phase of the CED, CAD evaluation program. The objectives of this phase were to identify possible use of a CAD system within CED and to identify the generic type of CAD system that would best satisfy CED's requirements.

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The first order of the investigation was to review directorate, division and branch missions. Next, CAD vendors were visited to witness demonstrations and to discuss various aspects of each package presented. Finally, a sampling of CAD users were visited.

It was determined that many manual methods now in practice in CED can be improved by a CAD system. Redundant and repetitive drafting operations can be dramatically improved. Tedious, time consuming, and error-prone activities such as BOM extraction, and cable running list development can be done by a CAD system in a fraction of the time presently required with error-free results. CAD systems hardware capable of meeting CED's specific requirements are commercially available from a few vendors. However, application software will have to be written.

This report recommend~~ed~~s that ~~to obtain~~ a pilot CAD system to be used for initial applications development, economic analysis, productivity measurements, etc. The documentation resulting from this effort will provide a sound reference to decide upon the expansion of CAD throughout USACEEIA.

COMMUNICATIONS ENGINEERING DIRECTORATE

AUTOMATION ANALYSIS

PHASE I REPORT

Contract Number DAEA18-79-D-0059/0163
February-April 1983

Kentron International, Inc.

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MANAGEMENT OVERVIEW

SECTION I. MANAGEMENT OVERVIEW

1. SCOPE

1.1 Introduction. This report documents the results of the investigatory phase of the CED, CAD evaluation program. The objectives of this phase were to identify possible use of a CAD system within CED and to identify the generic type of CAD system that would best satisfy CED's requirements.

1.2 Summary. The Task Team's efforts were focused on three major activities:

- o An indepth look at CED.
- o Visits to CAD vendors.
- o Visits to CAD users.

a. The first order of Task Team activity was to review Directorate, Division, and Branch missions. This led into detailed interviews with personnel from the functional Branches of CED. Areas investigated were EIP development methodology, BOM development, standard symbology, current computer usage, and inter-branch activities and communications.

b. The second major activity was to visit CAD vendors to witness demonstrations, and to discuss hardware and software aspects of each vendors offerings.

c. The third major activity was to visit a sampling of CAD users. Engineering firms and Service Bureaus who are currently using CAD systems in their engineering plans.

1.3 Conclusions.

1.3.1 Affirmations. Many manual methods now in practice in CED can be improved by a CAD system. Redundant and repetitive drafting operations can be dramatically improved. Tedious, time consuming, and error prone activities such as BOM extraction, and Cable Running Lists development can be done by a CAD system in a fraction of the time presently required with error-free results. CAD systems hardware capable of meeting CED's specific requirements are commercially available from several vendors.

1.3.2 Concerns. Few if any Application Software packages are available to meet the specific applications required for CED. In order to meet these application development demands, application software personnel will be required. It is anticipated that these demands will continue to grow for as long as CED has a CAD system.

1.4 Recommendations.

a. Move swiftly into the next phase of the evaluation program.

b. Obtain a pilot CAD system to be used for initial further applications development, economic analysis, productivity measurements, etc. The documentation resulting from this effort will provide a sound reference to decide upon the expansion of CAD throughout USACEEIA.

SECTION II

TEAM STUDY

1. THE TASK TEAM

Detailed discussion of the Evaluation Program with senior personnel in CEEIA resulted in the selection of key managerial staff and operation personnel for the project. A corresponding senior CAD specialist was chosen to operate with the group. This organization structure is depicted in figure 1.

The Task Team was formed to develop a comprehensive view of CED practices in a cohesive investigatory manner. It was decided that a Program Manager be appointed to coordinate team efforts and to be the focal point for communication for all participants in the program.

The Program Manager from CEEIA was Mr. Chuck Hansford who provided a broad view of CEEIA activities, and in-depth knowledge in the area of transmission and Radio Engineering. Mr. Tom Bakey served as the CAD specialist. Mr. Bakey possesses vast experience in CAD, and CAD applications and has worked with many large Architectural, Engineering, and Construction firms over the past several years.

In addition to the Program Manager and specialist, it was decided that operational personnel be included to provide detailed insight into ACC activities, and to aid in the collection and analysis of any pertinent information.

The primary operational participant from CED was Project Engineer, Mr. Paul Smith. He assisted with the investigation in a variety of ways, and contributed indepth knowledge in the radio engineering and data application activities, as well as providing real world "case studies" in many instances.

Mr. Bakey was supported by various industry specialists on an "ad hoc" basis as various requirements needed special clarification.

CED's management staff was also involved receiving progress reports and information, and providing advice at selected points throughout the Program.

The Task Team approach was a successful means of directing the investigation, collecting and analyzing the information required for a mutually beneficial program.

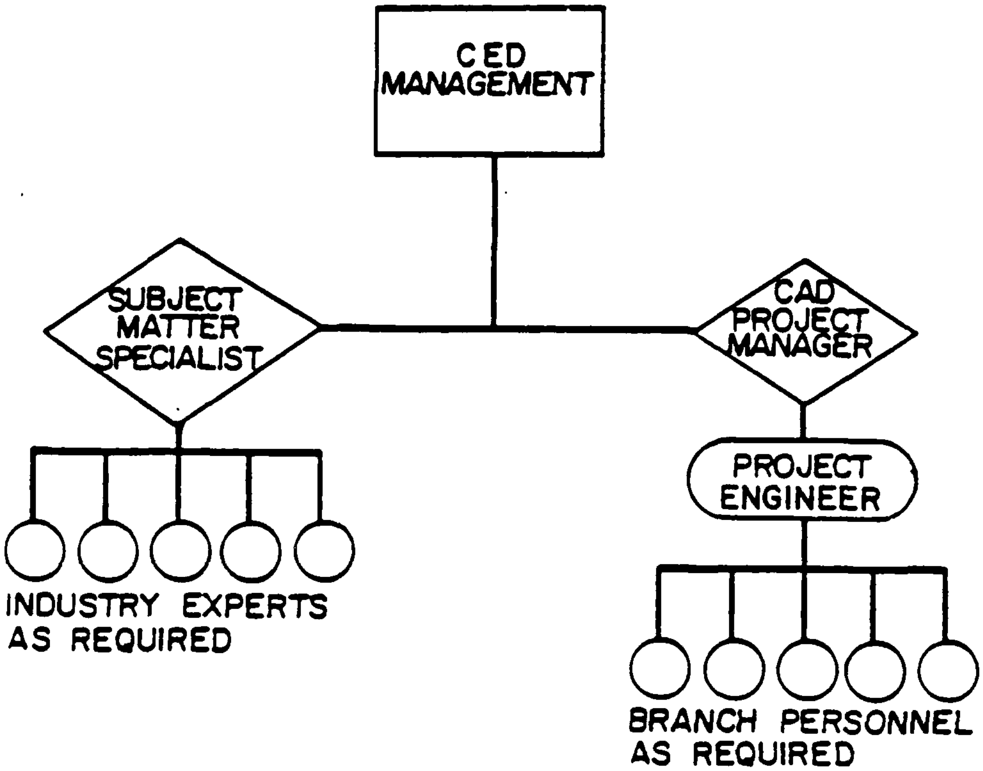

FIGURE 1 TASK TEAM ORGANIZATION

2. METHODOLOGY

2.1 Introduction. The investigation was divided into three major activities:

- o CED Branch analysis.
- o CAD vendor analysis.
- o CAD user visits.

2.2 CED Branch analysis.

The analysis was based on a comprehensive and thorough approach, beginning the examination with CED organizational overview and expanding into a detailed investigation of specific Branch activities.

The Task Team established a common understanding of goals and objectives agreeable to both the engineering and management oriented participants. This was achieved through sessions involving an exchange of information among the team members; CED personnel at the Branch level providing fundamental insight into various aspects of their activities and the Task Team conveying information on Computer Aided Design (CAD) capabilities.

Letters, agendas, and suppport material were prepared for most sessions during the analysis study, serving as a reliable means of communication and providing continuity and direction throughout the Program.

Collectively the Task Team established a plan and schedule for achieving the agreed upon objectives. The schedule included an outline of investigatory phases and their corresponding time estimates for each of the participants. Target dates and report cycles were integrated into the plan.

The Task Team began the investigation by reviewing Divisional and Branch organizational missions. These missions furnished a reference base from which the investigation proceeded.

The Task Team continued by outlining Branch activities, such as Voice, Data, Satellite, etc. This included a study of Engineering Installation Packages (EIPs), analysis functions, reports and reporting cycles, and other important aspects of Branch activities. Much of the information was gathered by looking closely at drawing documents, BOMS (Bills of Material), and various reports.

Conducting interviews with selected CED personnel was another helpful method of gaining an understanding of Branch and Inter-branch activities. The investigation yielded information on standard symbology, drawing methodology, drawing layouts, and the identification of work-load distributions.

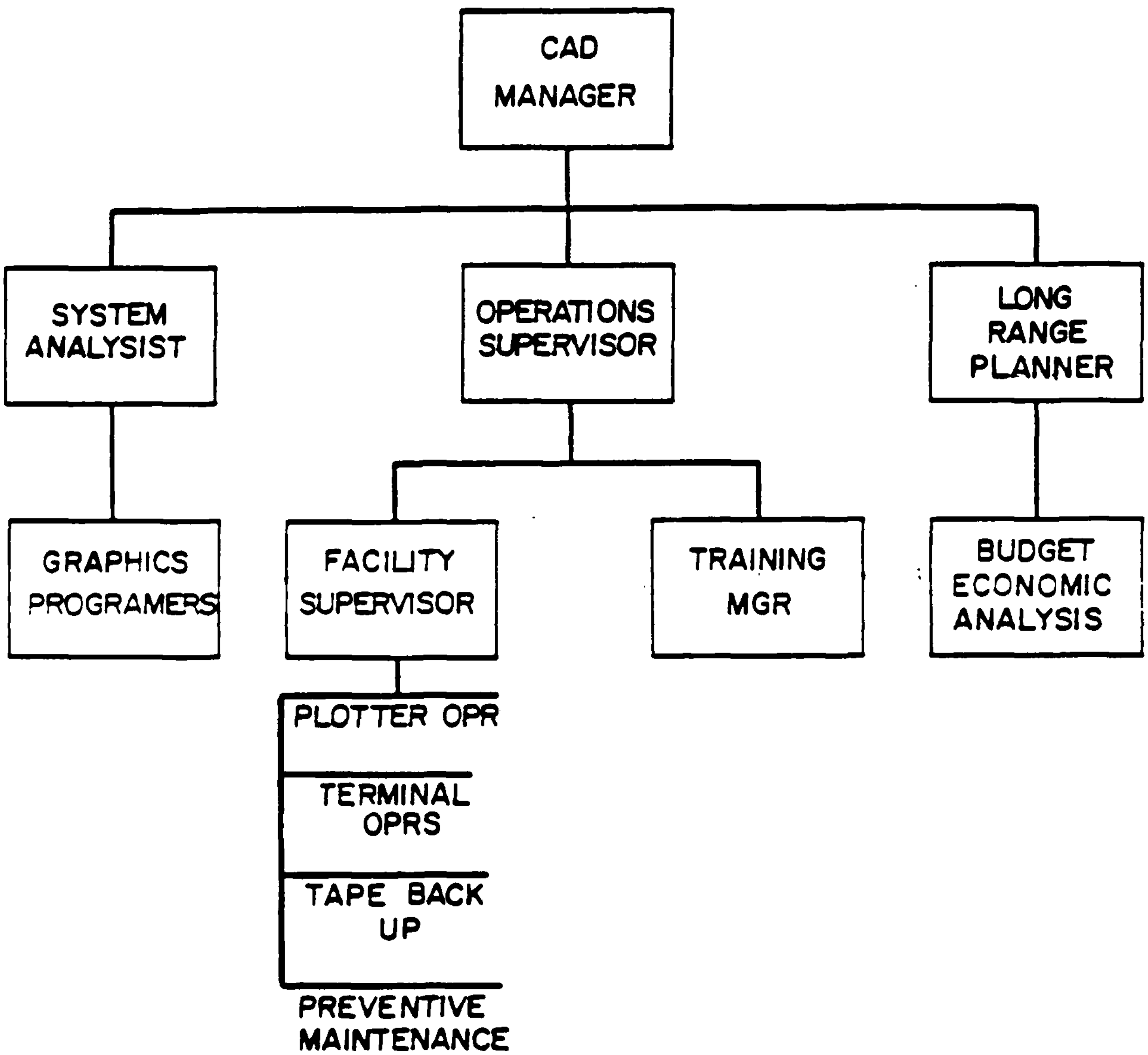

FIGURE 4 CAD ORGANIZATION TYPICAL OF THE AE&C INDUSTRY

6. RECOMMENDATIONS

6.1 Management requirements. The development of any management strategy should not be based exclusively on past experiences. In fact if this philosophy is adopted, then management becomes anachronistic and dealing with the past becomes the present issue.

The management focus for the CAD system use must come from the top. CAD systems and their applications are rapidly changing technologies and must be met and managed by modern management techniques. With the implementation of CAD at USACEEIA, the belief that a computer system belongs in one place and the computer user in another will become a concept of the past. With CAD, the computer and the user will be integrated and operating in one physical area. The engineer will use the CAD system much like his slide rule or hand-held calculator only with much more accurate, efficient and effective results. However, unlike the slide rule and hand-held calculator the engineer needs "close in" support in the form of applications programmers and system analysts. This support will enable the engineer to operate the system for maximum utilization. These support personnel should not be a part of the organizations main frame computer center, but should be a part of the CAD organization.

Many large companies that have benefited by the use of the CAD systems recognized this decentralization between their main frame computer operations and CAD systems early in their CAD implementation program. They developed a CAD management structure effective in execution and similar to the organization shown in figure 4.

6.2 Warnings.

6.2.1 Application support.

It is anticipated that few if any of the CAD systems available and under consideration for use will meet the specific requirements demanded by application within CED.

Most system hardware elements defined are available, but the system application packages will have to be developed and implemented as the system matures.

In order to meet these application development demands, application software personnel will be required. These personnel can be hired to develop programs on an application development basis or they can be integrated as permanent members of the CAD system management team.

6.2.2 Suggestions.

a. CED senior applications personnel be employed to operate within the CAD system organization structure. They would be responsible to develop present and future CAD application requirements and programs.

b. Vendor application personnel be utilized during the initial evaluation phase of the program.

and continuing support from the highest levels of management to be able to use the system to its fullest capabilities. Management must realize and accept the fact that the installation of a CAD system may require wide ranging changes in the organizational structure and in many of the ways in which the organization does its work.

5.5 Management organization establishment. The first, and most obvious of the required organizational changes is the establishment of an organization to manage the CAD system. The Task Team recommends, as a minimum, the following personnel be made available to establish and manage the initial pilot CAD system:
A dedicated staff assigned to or under operational control of the Director, CED.

- o CAD manager
- o Planner (for long range planning, system expansion budgeting)
- o Systems Analyst (to interface between engineering personnel and programmers in developing applications software)
- o Programmers (to provide the detail flow diagrams and application codes)
- o Trainers (to teach and train personnel on existing and future packages)

A more in-depth treatis of the CAD management organization will be presented in the next section, Recommendations.

5. CONCLUSIONS

5.1 Engineering productivity. The introduction of a CAD system into the CED organization promises to have a dramatic effect on the engineering productivity of many of the operational branches. The cross section of industrial users of CAD sampled as well as the many technical books, journals, and other publications reviewed during Phase I of the study revealed a wide range of productivity increases are being realized following an initial three- to six-month period of time after installation of the CAD system. While many of the CAD users experienced a slight drop in productivity during the first few months after start-up, their personnel were able to demonstrate gains of 2:1 on very complex tasks to well over 20:1 on routine drafting work. The engineer is now able to enter his design concept directly into the machine, perform his required calculations or analysis, which earlier required a time consuming manual computation using slide rule or hand calculator and reference to nomographs, tables or hand books, and be able to see in real time the effects of changes in the engineering scheme. Once the engineer is satisfied with his design he is able to rapidly produce an "A" size check print or even a finished "C", "D" or "E" size drawing. The CAD system has eliminated the lengthy wait required while an in-house drafting service bureau produced an engineering check print. If changes are required by higher level management or the customer they may be rapidly added to the database stored in the CAD computer, analyzed, data manipulated and extracted in the form of drawing revisions, bills of material, and cost figures.

5.2 Technical specifications. The Phase I review of the technical specifications of over 20 of the largest CAD vendors has indicated that over 85 percent of the vendors produce CAD hardware that will meet CED's needs. The Generic CAD system envisioned by the Task Team for CED is available "off-the-shelf" with the ability to interface to add-on peripheral devices at a later time. Most of the CAD vendors are using 32-bit minicomputers as their central processing units with the majority selecting the DEC VAX-750 as their CPU. There are still a few companies that have made the corporate decision to remain with the older 16-bit CPU technology.

5.3 Hardware/software packages. While many of the CAD vendors are able to supply the hardware required by CED, specific application software packages required by CED beyond a simple 2-dimensional drafting package are almost nonexistant. CAD vendors are very reluctant to spend the time and effort necessary to develop customized software packages for their customers. Their approach seems to be to develop a software package with enough of a universal appeal to sell their turn-key hardware systems and defer application programming to the user to develop his own applications packages. The cross section of CAD users contacted has reinforced this point. The user must develop his own software from either in-house or external resources, acquire it from User Groups, or purchase programs from third party software houses.

5.4 Organizational structure changes. The dramatic increases in engineering productivity mentioned in paragraph 5.1 above do not come free. A CAD system is not a hand-held calculator, it requires a substantial outlay of capital

CUMULATIVE COSTS

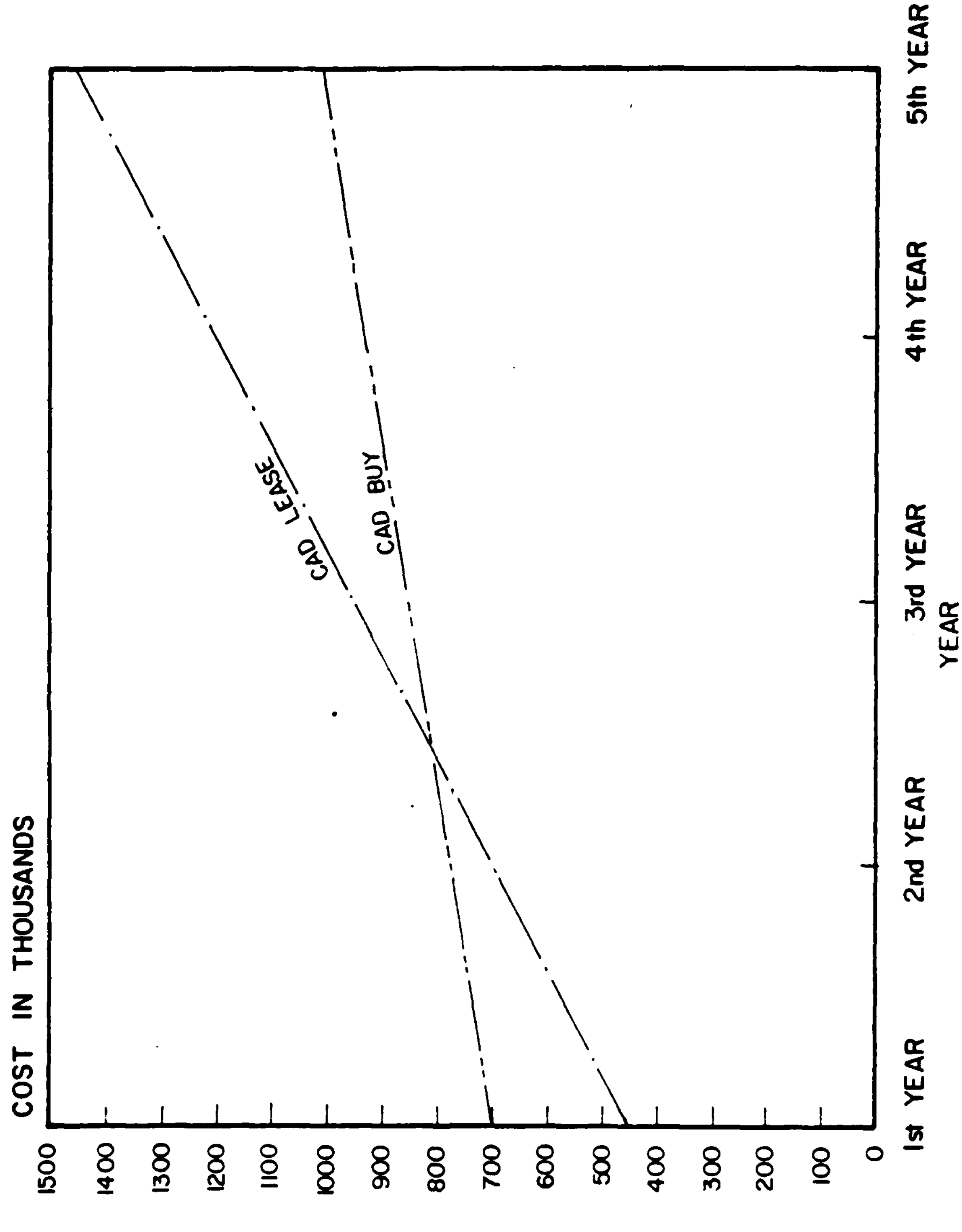

TABLE 3

YEARLY COSTS

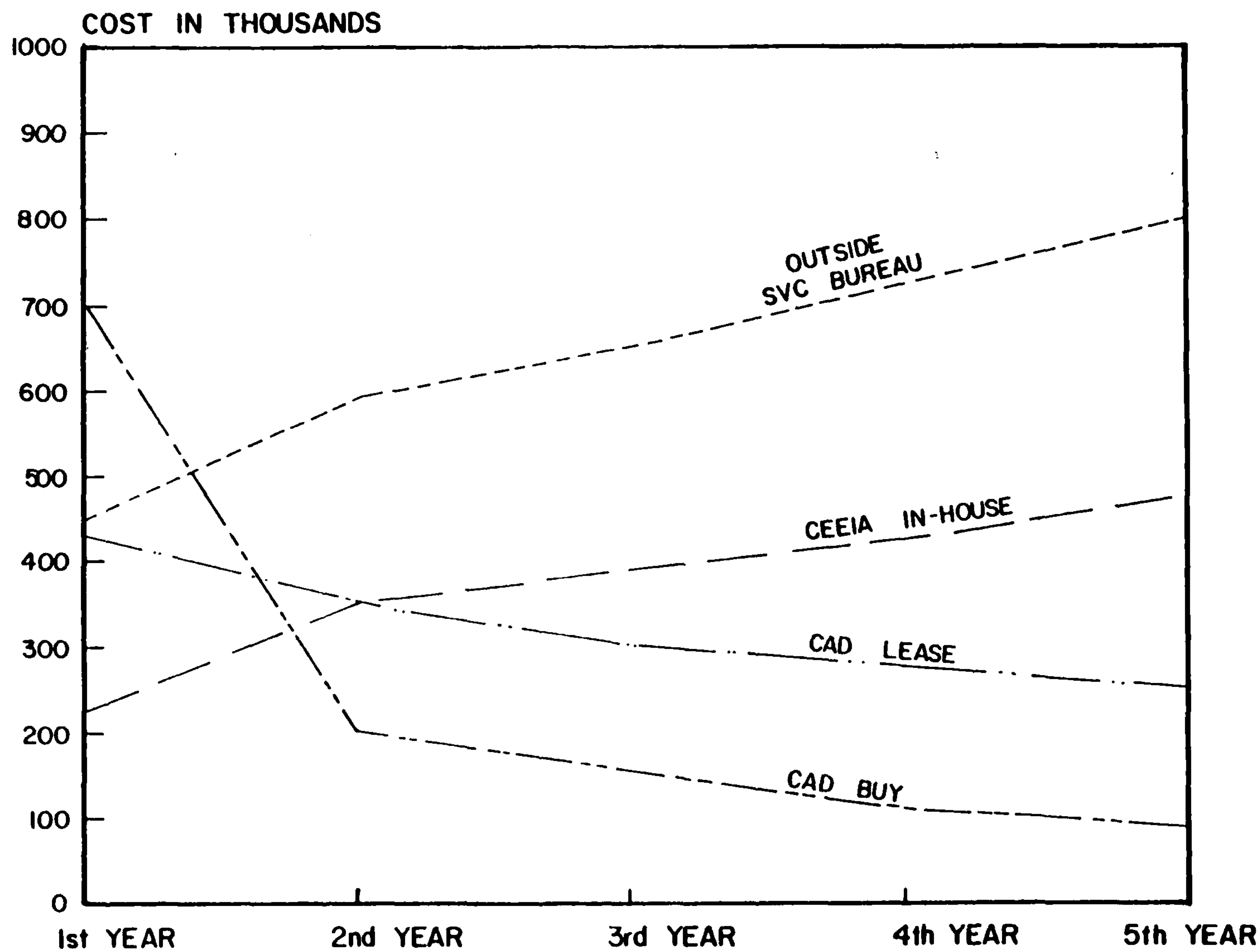

TABLE 2

ECONOMIC ANALYSIS

	CURRENT FY	FY + 1	FY + 2	FY + 3	FY + 4
Personnel cost	173.6K	249.7K	355.5K	369.7K	384.5K
Burden (27.3%)	47.4K	68.2K	97.1K	100.9K	105 K
TOTAL	221 K	317.9K	452.6K	470.6K	489.5K

Alternative 2 (Outside Service Bureau)

	CURRENT FY	FY + 1	FY + 2	FY + 3	FY + 4
Direct Labor	190K	230K	340K	340K	340K
Labor overhead	190K	230K	340K	340K	340K
Other direct costs	0	0	0	0	0
Site burden	19K	23K	34K	34K	34K
G & A expense	20K	24K	36K	36K	36K
Profit or fee	21K	25K	38K	38K	38K
TOTAL	440K	532K	788K	788K	788K

Alternative 3 (Purchase CAED)

	CURRENT FY	FY + 1	FY + 2	FY + 3	FY + 4
Personnel	29.4K	31.6K	32.6K	33.9K	35.3K
Burden (27.3%)	8 K	8.6K	8.9K	9.3K	9.6K
Site preparation	20 K	------	------	------	------
Equipment, software	422 K	------	------	------	------
Maintenance	28 K	28 K	28 K	28 K	28 K
Software development	150 K	50 K	50 K	50 K	50 K
Training	10 K	------	------	------	------
TOTAL	677.4K	118.2K	119.5K	101.2K	87.9K

Alternative 4 (Lease CAED)

	CURRENT FY	FY + 1	FY + 2	FY + 3	FY + 4
Personnel	29.4K	31.6K	32.6K	33.9K	35.3K
Site Preparation	20 K	------	------	------	------
Burden (27.3%)	8 K	8.6K	8.9K	9.3K	9.6K
Equipment, software	190 K	190 K	190 K	190 K	190 K
Training	10 K	------	------	------	------
Maintenance	28 K	28 K	28 K	28 K	28 K
Software development	150 K	50 K	50 K	30 K	15 K
TOTAL	435.4K	308.2K	309.5K	291.2K	278 K

TABLE 1

4. CAD SYSTEM COSTS

An economic analysis for the CED CAD evaluation system was performed against projected in-house costs and service bureau rates. The options were based on an initial 5:1 productivity increase and eventual 10:1 increase when using a mature CAD system for the same work. These productivity figures are averages derived from industrial user experiences. Note that the work referred to is installation planning and EIP generation which is currently a labor intensive and time consuming process and therefore shows the greatest potential for these high productivity gains.

The lease versus buy cost figures are given for a single stand-alone CAD system with one operator. The entire capital investment is made during the first year in order to buy the system but for a lease the equipment costs are recurring.

Table 1 presents the detailed five-year cost breakdown figures.

Table 2 graphically shows year-by-year annual cost for each option.

Table 3 shows cumulative cost over the five-year period for both the lease and buy options. Note that purchase of the system is economically advantageous after the third year.

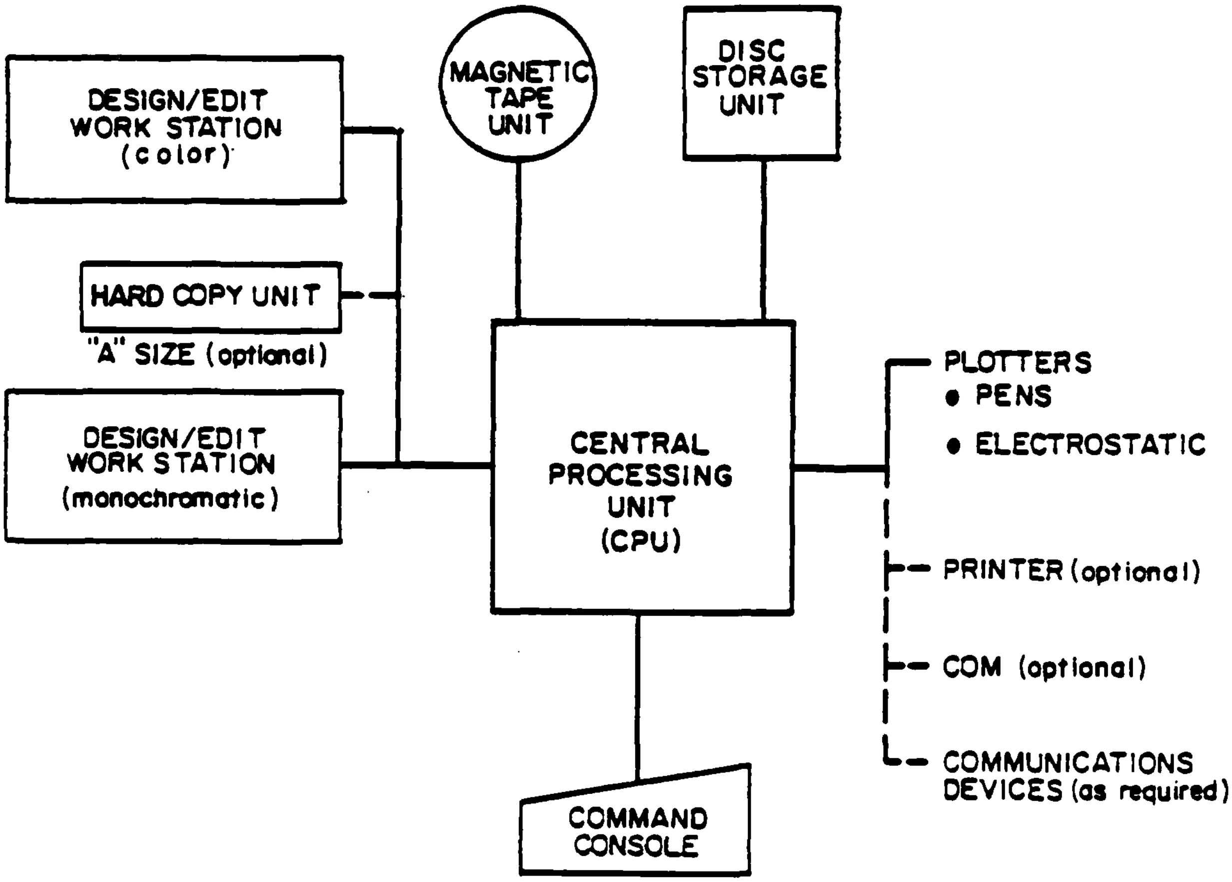

FIGURE 3 CAD SYSTEM CONFIGURATION

3. GENERIC CAD SYSTEM

3.1 Introduction. The CAD system is a combination of hardware and software configured much like any other computer system except that emphasis is placed on graphical I/O and the resulting ergonomic considerations which that entails.

3.2 Hardware.

The hardware core of a CAD system is comprised of the following four major items. Note that the processor may support other peripheral equipment as appropriate.

- o Processor
- o Graphics terminal
- o Mass-storage
- o Plotter

The selection of CAD hardware is primarily based on the importance of establishing an interactive relationship with the CAD operator. This is achieved by minimizing response times and by use of interface techniques which the operator perceives as natural such that it elicits spontaneous interaction. High resolution color display and spatial input via light pen or X-Y tablet and puck combined with menu driven software can meet this objective.

Current design trends will lead to the integration of the graphics terminal, processor, and a portion of the mass-storage into a stand-alone intelligent workstation which can be a participant in database networking. However, the present state of the art has the processor as a 32-bit superminicomputer supporting several graphics terminals. It is imperative that as much processing power as is practical be dedicated to each individual workstation in order to minimize response times. A block diagram of a generic CAD system suitable for CED evaluation is presented in Figure 3.

3.3 Software.

Software for CAD may be classified in three general catagories.

- o Basic operating software
- o Database
- o Applications package

A necessary capability of CAD is to have a basic operating software system. The basic operating system controls the workstation display(s), graphical input and operator prompting and provides a general system control capability. The database contains the data necessary to access and maintain a comprehensive collection of interrelated graphical, numerical, and narrative data. The applications package links the information in the database to generate specific programs within an application. Application packages provide the information interaction and analysis required to transform CAD from a simple drafting tool to an engineering and design system.

2.5 User visits.

To obtain a CAD perspective from a user's viewpoint, visits were made to a large engineering firm, Bechtel Corporation, and to a CAD Service Bureau, Royal Communicating Graphics; both in the San Francisco, CA area. One company has had CAD for five years while the other has had CAD experience for over ten years.

Each company was asked what advice they would give to an organization entering into CAD for the first time. The following is a compilation of their responses:

a. Vendor software support is practically non-existant. Vendors develop software with sufficient universal application to be able to sell their hardware but have little interest in writing specific user applications programs. This is understandable from an economics standpoint since CAD sales have been growing at the rate of 100 percent per year for the last five years.

b. When procuring CAD systems, emphasize the hardware specifications. Defining system performance parameters is next to impossible due to their dependence on specific user applications.

c. Full corporate commitment to CAD is a must. CAD systems are very expensive in both the initial investment and the overhead required to properly manage, plan, and operate. Every organization who has successfully implemented CAD has accepted the commitment to properly staff the CAD management organization.

d. Rewards of implementing CAD are high. When the proper commitment is made productivity increases range from 5:1 up to 20:1 or higher depending on the application and implementation of the CAED System.

2.3 Vendor analysis.

Objectives of this portion of the evaluation were to assess currently available hardware and software, and to determine the ease with which an operator may interact with the CAD system.

To investigate current CAD technology, requests for commercial literature were sent out to a broad spectrum of vendors of CAD systems. After analysis of the information received, visits were made to vendor facilities on the west coast to observe equipment demonstrations and to see complete CAD systems in operation.

Due to schedule constraints, vendor visits were confined to a one-week trip to the west coast to reduce travel costs and time. In spite of this restriction, a very good cross section of the CAD industry was achieved. The following vendors facilities were visited:

- Intergraph
- Applicon
- Calma
- Cadtrak
- Tricad
- Hewlett-Packard
- Prime computer
- IBM
- CDC

In the area of hardware, the systems observed varied from a low-resolution, single screen, 16-bit processor "drafting system" to a high resolution, dual screen, 32-bit processor engineering/design system.

Software packages available from most vendors include:

- Electrical - printed circuit/IC chip design.
- Mechanical - piece part design.
- Drafting - 2 dimensional.
- Process - petrochemical plant design.
- Mapping - includes utilities management.
- Architectural -
- Civil - cuts, fills, roads, etc.
- Structural - steel, concrete, and bridge analysis.

Although portions of the application packages listed above may be adapted to meet some of CED's needs, there are no known applications packages to meet specific CED requirements.

2.4 Ergonomics. The methods of human interaction with the system varied over a wide spectrum. At the lower end, practically all operator commands to the system were through keyboard entry. At the high end, operator commands were via a light pen or X-Y tablet and puck combined with menu driven software.

APPLICATIONS	BRANCH						
	DATA	TI	SAT	RADIO	VOICE	PROP	AAF
GENERAL MANAGEMENT SUPPORT							
-- Time/Task flow analysis (Project status reporting charts)	X	X	X	X	X	X	X
-- Business graphics (Briefing aids)	X	X	X	X	X	X	X
-- Configuration management (Archival storage and maintenance of as-built site data)	X	X	X	X	X	X	X
INSTALLATION PLANNING (EIP Drawings)							
-- Site layout (maps, terrain, roads, buildings, towers, utilities, etc.)	X	X	X	X	X	-	X
-- Architectural matrix (Building structure, walls, openings, plumbing, HVAC, power entry, etc.)	X	X	X	X	-	-	X
-- Floor plans with equipment footprints	X	X	X	X	-	-	X
-- Rack face elevations	X	X	X	X	-	-	X
-- Conduit, waveguide, raceway, cable tray runs	X	X	X	X	-	-	X
-- AC & DC power distribution	X	X	X	X	-	-	X
-- Penetration layouts	-	X	X	X	-	-	-
-- Distribution frame layouts	X	X	X	X	X	-	X
-- Floor plan overlays	X	X	X	X	X	-	X
-- Functional block & wiring diagrams	X	X	X	X	-	-	X
-- Generalized drafting capability	X	X	X	X	X	-	X
-- Standard engineering installation details	X	X	X	X	X	-	X
INSTALLATION ANALYSIS (Application Programs)							
-- 3-dimensional interference checking	X	X	X	X	X	-	X
-- BOM list derived from multiple sources	X	X	X	X	X	-	X
-- Cost approximations	X	X	X	X	X	-	X
-- Branch data base sharing	-	X	X	X	-	-	-
-- Cable routing	X	X	X	X	X	-	X
-- Cable running list	X	X	X	X	-	-	X
-- Cross connect list	X	-	-	-	-	-	X
-- Electrical power & heat load calculations	X	X	X	X	-	-	X
-- Standard detail selections	X	X	X	X	X	-	X
ENGINEERING ANALYSIS							
-- Utilization of higher order languages	X	X	X	X	X	X	X
-- Graphical I/O (Data entry via X-Y tablet, Numeric output via X-Y plot. Color display of data in 2 & 3 dimensions)	-	-	-	-	X	X	-
-- Mainframe interface (Remote I/O for Cyber)	X	X	X	X	X	X	X
-- Word processing interface	X	X	X	X	X	X	X
-- Application programs Coordinate transformations Path profiles RF power losses Antenna graphics (3-D) Schematics Circuit performance	X	X	X	X	X	X	X

Figure 2. CAD applications.

The development of Project Flow Requirements reflected the flow of CED activities from initial tasking through engineering, installation and into plant-in-place drawings. Each stage of the requirements served as a point of review and analysis. Included were discussions on the potential impact of CAD on present management and reporting practices.

Current computer usage, ranging from hand-held calculators to larg~ mainframe computers were reviewed, analyzed, and documented.

In identifying potential applications of CAD, the following general catagories were identified:

- General management support
- Installation plannning (EIP drawings)
- Installation analysis (application programs)
- Engineering analysis

Further amplification of these catagories, as well as identification of the specific Branch of CED to which they apply, is contained in figure 2.

It should be noted at this point that time and scheduling precluded an in-depth study of EMC, CEEB, and Secure Voice. These Branches will be studied during phase II of the investigation.

All of the other Branches of CED were interviewed/investigated. Those Branches shown on figure 2 are considered to be the primary candidates for CAD.

In this type of structure the CAD manager is responsible for all CAD activities within the group. He would or could be reporting at the Branch or Division level. Under and in his domain is this recommeded and required support organization:

- o The Planner
- o The System Analyst
- o The Operations Supervisor

a. The Planner is required to identify current and long range extensions to the existing CAD system. In adaition he/she would be responsible for all required budgeting, economic analysis, and preparing required justification documentation.

b. The System Analyst is required to formulate specific applications programs in conjunction with CED engineering personnel and CAD staff graphics programmers.

c. The Operations Supervisor is responsible for the day to day operation of the CED CAD system. His/her duties include training of operators and other users of the CAD system as well as backing up the system and performing routine preventitive maintenance.

6.3 Areas requiring further study.

6.3.1 Unvisited CED Branches. Due to time and scheduling constraints, two of the operational branches of CED and a portion of a third were not analyzed during Phase I. These were CEEB, EMD, and the Secure Voice portion of the Secure Voice and Airfields Branch. It is the intent of the Task Team to pick these branches up as part of Phase II. It is not felt that the findings in these organizations will alter the conclusions and recommendations of this Phase I report.

6.3.2 OCONUS Branches. It is anticipated that once a CAD system has been installed in CED the next logical step would be to extend the system into the three satellite commands; that is, CEEIA CONUS, Fort Ritchie, MD; CEEIA EUROPE, Worms, GE; and the Detachment-Korea, Seoul, Korea. The first order of business during Phase II will be to visit these satellite commands to define their requirements for a CAD system and to identify a means of communication engineering data to and from Fort Huachuca, AZ.

6.3.3 Phase II preliminary plan.

a. Complete visits to three remaining CED branches.

b. Visit and analyse satellite commands. visit Navy CAD center at Pearl Harbor, HI., as well as the USAF counterpart at Tinker AFB, OK.

c. Present technical paper at NCGA convention, Chicago, IL.

d. Evaluate final CED CAD technical specification.

e. Evaluate vendor proposals.

f. Prepare CAD site preparation specifications and work order.

g. Establish CED's CAD management organization.

- o Interview personnel
- o Train management team personnel

h. Acceptance testing of CAD system at vendor's site.

i. Training of operator personnel at vendor's site.

j. Develop specifications for initial applications packages.

k. Monitor development of initial applications packages.

l. Interface CAD to CDC Cyber 730 mainframe computer.

m. Acceptance testing of the CAD system at Fort Huachuca.

n. Training of Army personnel on installed CAD system at Fort Huachuca.

o. Detailed economic analysis of the installed CAD system.

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70. Standardized procedures
80. Shorter training cycles
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APPENDIX A

EXPECTED CAD BENEFITS FOR CED

10. Introduction. A CAD system operating at USACEEIA would be integrated into several major Branch activities. (Refer to figure A-1.) The system would be used by Engineering personnel in the initial phases of project activity. It would be used as an engineering tool to develop and produce the required drawings and documents, and allow Branch Management to collect and analyze documents and reports. Branch management could further act on the information, to develop and review the implementation plan for construction personnel.

All these activities would result in the following benefits for CEEIA:

- o Increased productivity
- o Reduction in errors
- o Increased accuracy
- o Reduction in turn around time
- o A check and balance capability
- o Standardized procedures
- o Shorter training cycles
- o Aid to project management
- o Extensions to field site or branch locations
- o Minimize drafting needs and requirements
- o Automatic BOM generation

20. Increased productivity. The CAD system will increase productivity. This translates into a more efficient operation for USACEEIA, because it will reduce staff requirements on a given project, in addition to speeding response on "tight timetable" projects.

Assume for a moment a 5-to-1 enhancement on project engineering/documentation/completion time, when a CAD system is used.

This doesn't necessarily mean that an 18-month project will be completed in three and one-half months (5:1 reduction), because there are almost always other important factors. What it does mean, however, is only one-fifth of the total hours for engineering and documentation is devoted to the project to achieve the same result with a CAD system. (It could also mean the completion of the drawing and documentation of five projects in the same time span as one.)

As a general rule, any engineer/designer/drafter firm of approximately 10 to 30 members will find the CAD system productive and economically beneficial.

30. Reduction in errors. The CAD system will provide an intrinsic capability for avoiding engineering/drafting/documentation errors. Information errors (translation, transposition, and extension) that normally occur during material take-off or in generating bill of material, are virtually eliminated.

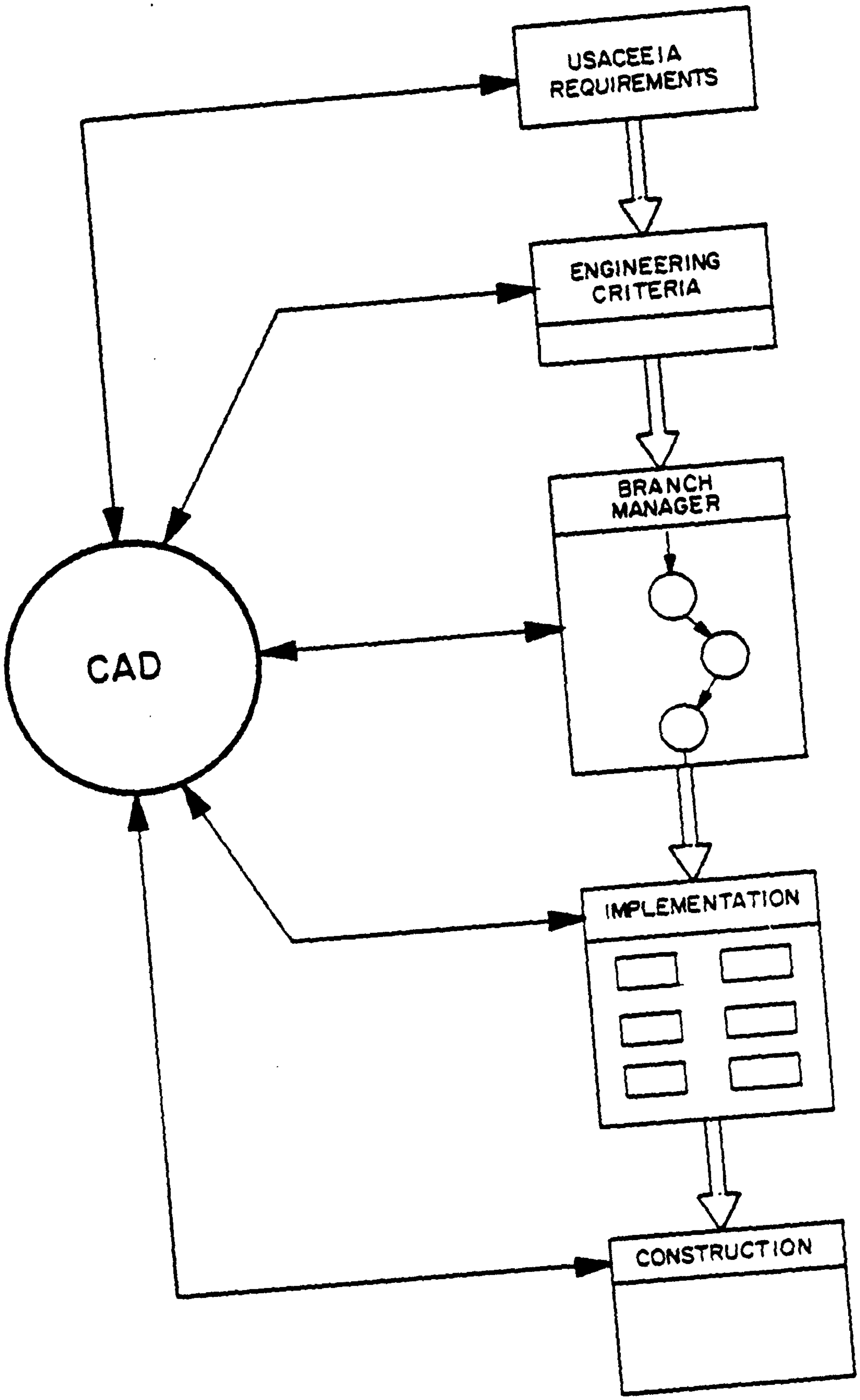


FIGURE A-1 CAD AT USACEEIA

The key reason for this is simply that minimal manual handling of information is required once the initial drawings have been produced. Errors are further avoided, because the CAD system performs best when executing time consuming repetitive duties, such as multiple symbol placement, sort by areas, or like items at high speeds with consistent and accurate results.

40. Increased accuracy. There is also extra-ordinary dimensional control far beyond the levels of accuracy attainable manually. Mathematical accuracy is routinely held to 14 significant decimal places, better than a 20-to-1 advantage over a architectural scale and hand-held calculator. The CAD system accuracy provide additional benefits. All parts on all drawings, on all listings, are always labeled by the same recognizable nomenclature, and number. Such accuracies are manifested in fewer Engineering Change Orders, Field Work Orders, resulting in more accurate material control, cost estimates, and tighter project supervision.

50. Reduction in turnaround time. The CAD system would reduce the turnaround time for drawings and documents. Inherently fast, it would speed up the tedious process of manually compiling material takeoff information. Thus, the system can produce a finished drawing and associated reports in a remarkably short time. for example, following traditional drafting methods, a D-size drawing of medium density could take up to four hours for completion. However, by shifting to a CAD system, the same drawing could be completed in less than 20 minutes. Manual to CAD system ratios vary depending upon the drawing and particular application, drawing size, and the density of information; but CAD system can produce increases in productivity ranging from 5-to-1, to as high as 30-to-1. The more complex the drawing, the better the CAD system performs.

60. Check and balance capability. The CAD system offers a new dimension in check and balance capability. Original drawings and reports are stored in the database of the system, much more accessible than documents which are difficult to retrieve, sometimes inaccessible. They can, therefore, be quickly checked against upgraded information. Since data storage is extraordinarily compact, historical information from previous drawings and reports, can be easily retained in the system's database for easy comparison with current engineering drafting needs. This flexibility, in database access, results in less checking time and fewer dimensional corrections on drawings, when compared with traditional methods.

70. Standardized procedures. The CAD system will help to standardize Engineering, Drafting, and Documentation procedures. A single database, common to all users, will provide a natural standard for engineering/drafting procedures. Management and supervisor personnel, as well as engineers and drafters, will be able to communicate efficiently and on the same terms. All work can be handled in a standardized, well structured manner.

80. Shorter training cycles. The CAD system affords shorter training cycles for new personnel. The reason for this is that the system "prompts" the user at the screen in a step-by-step manner. Therefore, each time a new employee or user, encounters an USACEEIA CAD system, he is obliged to communicate in the language that USACEEIA has established.

This ability to support training of new personnel not only accelerates their learning, but also allows senior members of the organization to concentrate on the more responsible tasks of planning, engineering, and project management.

The CAD system automatically presents the trainee with USACEEIA standard symbology and specifications, because they are built into each task the trainee performs. The CAD system encourages the trainee to teach him/herself how to work with the system. In the process of exploring uses of the system, the trainee is also exposed to USACEEIA procedures.

90. Aid to Project Management. The CAD system is most effective at the Project Management level. Here, CAD can assimilate information from within an application, or from various applications, for management review. Interactively, information shared between applications can be viewed and reviewed on the system. Questions on interferences; that is, cable raceway to steel, steel to HVAC, electrical to pipe, can be quickly resolved. The CAD system in these design review conferences, enable project managers to make decisions, implement, and make changes to the project database. The CAD system display capability, also eliminates the need to print excessive blueline or half-size copies for each engineering review conference. The CAD system can be the equivalent of bringing all the original tracings to a conference room or construction site for progress inspection and review. In essence, each project manager can be more efficient, and be better informed on engineering progress.

APPENDIX B

THE CAD SYSTEM

10. Introduction

20. Hardware components
20.1 Central processing unit (CPU)
20.2 Design/edit workstation
20.3 Disk storage unit
20.4 Magnetic tape unit
20.5 System console
20.6 Plotters
20.7 Computer output microfilm (COM)
20.8 Remote/terminal
20.9 Communications
20.10 High speed printer

30. Software
30.1 Operating system
30.2 The command processor
30.3 Application packages
30.3.1 Symbol library
30.3.2 Menus
30.3.3 Reports
30.3.4 Drawing borders
30.3.5 Interface to mainframe/timeshare computer
30.4 Database

40. Conclusion

APPENDIX B

THE CAD SYSTEM

10. Introduction. The CAD system is a combination of hardware components and software programs. The correct blending of hardware and software enable the system to be effectively utilized by providing a friendly and reliable environment in which to work.

The system is comprised of several basic elements. These elements are:

a. Hardware

b. Software

(1) Operating system software

(2) Command processor

(3) Application packages

(4) Database

A basic block diagram of a CAD system is illustrated in figure B-1, depicting the relationship among these elements.

20. Hardware components. The hardware elements of the system refers to the control console, magnetic tape drive, plotter, printer, design/edit workstations, monitors, central processing unit (CPU), and rotating disk storage unit. An illustration of these components is provided in figure B-2. All of these components are connected by communication cables, powered from standard electrical outlets. The interaction among these electronically connected components is initiated by software commands from the operator of the system.

20.1 Central processing unit (CPU).

The central processing unit (CPU) is a 32-bit computer capable of directing system traffic to and from all system components. It is also capable of executing the programs which accomplish tasks for the user.

The CPU has a variety of jobs to perform. At various times, it may interact with the engineer working at the workstation, or it may control the drawing on the plotter, or it may initiate a report on the printer, or transfer information from the disk storage unit to magnetic tape unit for archival and/or communications purposes. The CPU is the nerve center of the system, connected by cables to all other system components and other CAD systems for sharing of information. Also, it may be connected to larger mainframe and service bureau computers by magnetic tape, direct cabling, telephone or local area networks.

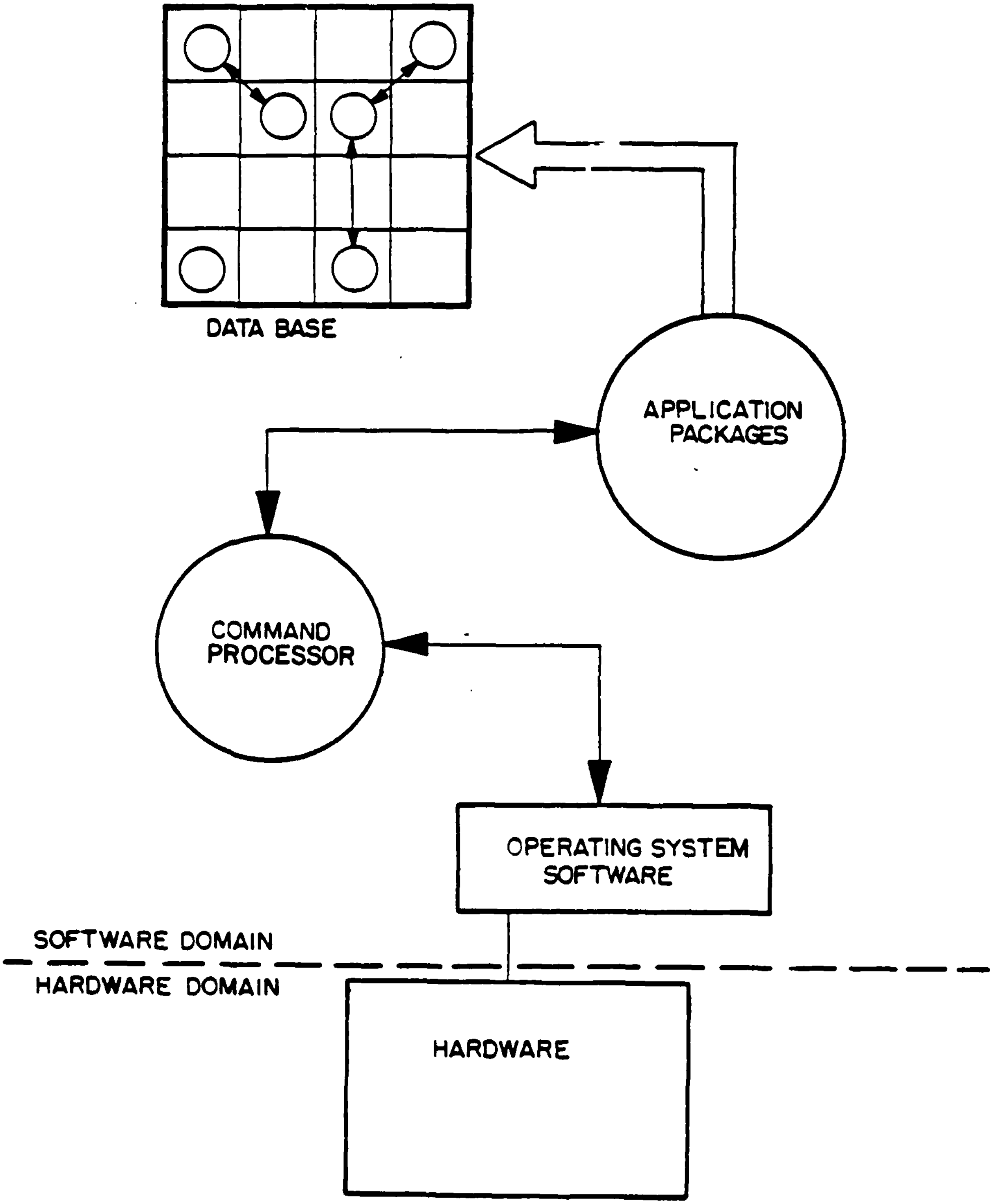


FIGURE B-1. CAD SYSTEM

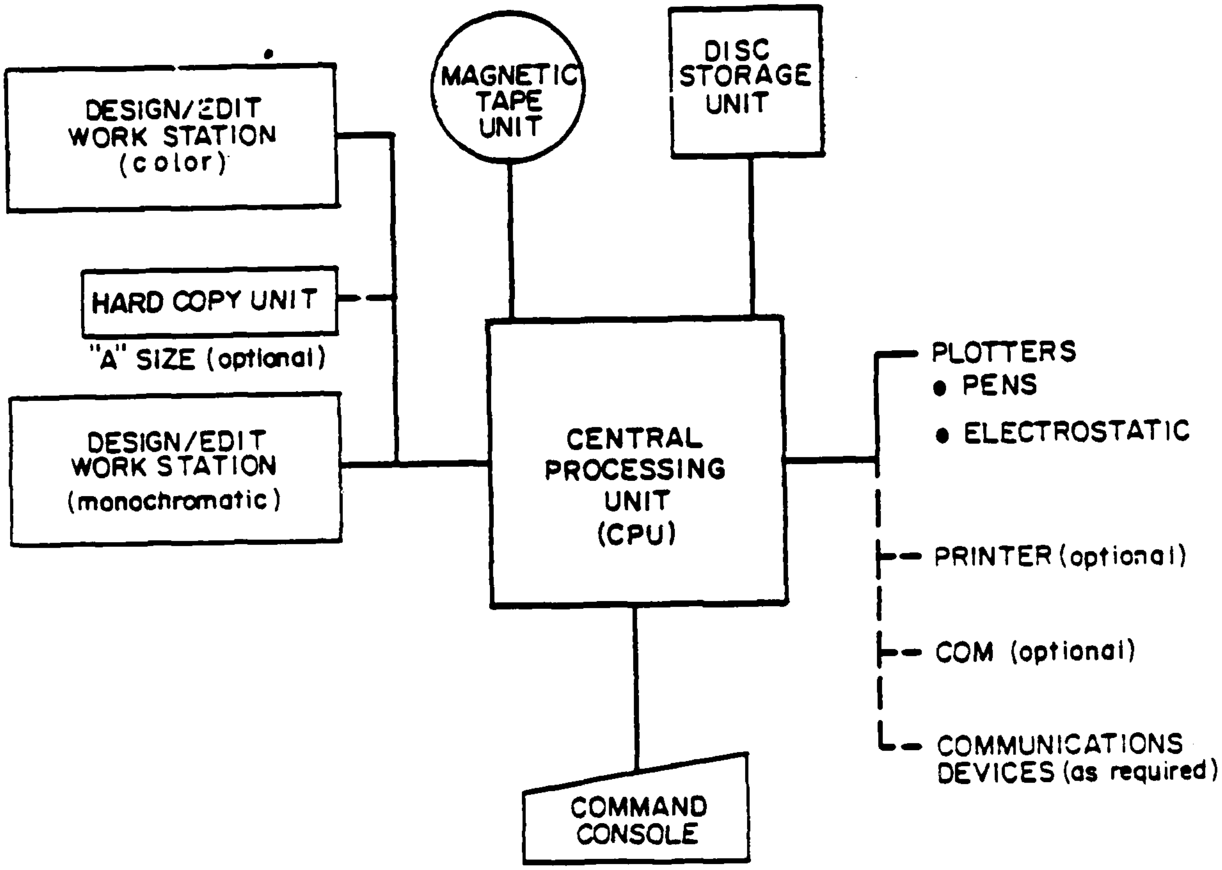


FIGURE B-2 CAD SYSTEM CONFIGURATION

20.2 Design/edit workstation.

The design/edit workstation is the focal point for most useful work. The engineer initiates all CAD commands from the workstation.

The workstation contains a graphics monitor, much like the screen on a television set, although it is capable of producing a much sharper picture. On this monitor the engineer views the image of his work which he controls with the use of an electronic tablet and pen or "puck", and a typewriter-like keyboard.

The graphics and pen allow the engineer to select from a "menu" of commands either on the tablet or on a corresponding area on the graphics monitor. These commands allow information to be seen at various scales and to be scanned, zoomed, plotted on the plotter, etc. Most all conceivable engineering functions are performed here, including documentation and report generation.

20.3 Disk storage unit.

The disk storage unit is a high-speed information storage and retrieval device. Like all other components of the CAD system, it receives its instructions from the CPU.

It is directed by the CPU to store information gathered at the design/edit workstation, from the magnetic tape unit, the system console, or from other CAD systems and large mainframe computers.

It is also directed to retrieve information and programs which have been stored previously.

Disk storage units come with various capacities and transfer speeds. The capacity of the unit is usually determined by the number of drawings and reports the system must contain at any given time. (Other drawings and reports may be archived on magnetic tape.) A general formula is that over 650 E-size drawings can be placed in 80 megabytes of storage space on the disk unit.

The speed of the disk unit can vary as well, but a typical example of transfer speed is that a complete E-size drawing can be "moved" from the disk to an output monitor or to another device in less than thirty seconds.

20.4 Magnetic tape unit.

The magnetic tape unit is a mass storage device, primarily used for the storage and retrieval of large quantities of information.

Some examples of items stored on magnetic tapes are catalogs, parts lists, specifications, and large quantities of drawings and reports which are required, but are not being accessed by the central processing unit on a continuous basis.

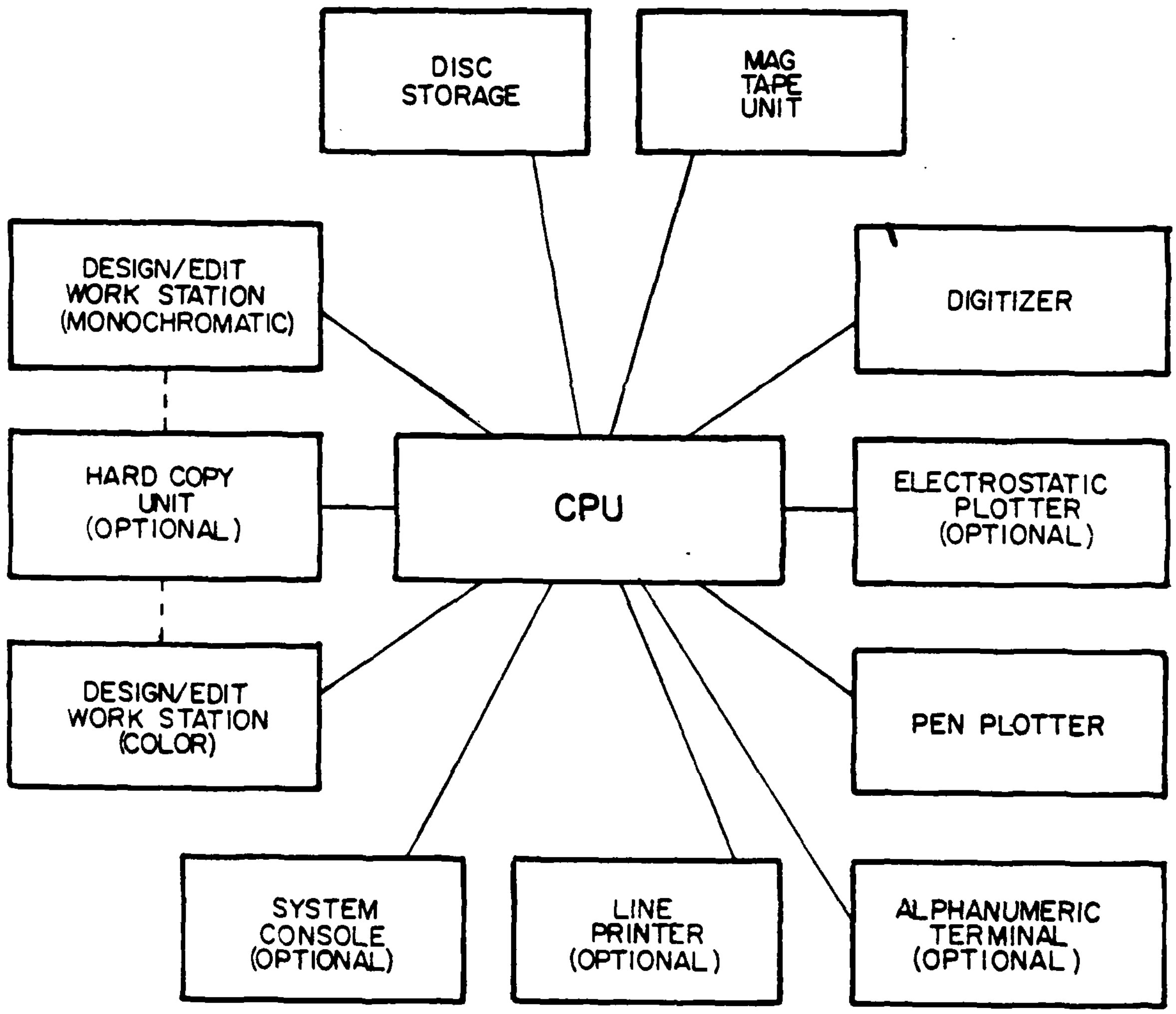


FIGURE C-1. DESIRED CED CAD CONFIGURATION

APPENDIX C

THE DESIRED CED GENERIC CAD SYSTEM CONFIGURATION

10. Introduction. The CAD system best suited for use at the USACEEIA is a dual workstation unit operating with a 32-bit computer, system console, and associated disk and tape units. This configuration is ideal for a first installation. It contains all of the capabilities, speed and flexibilities (less specific application programs) required for USACEEIA use. As more demands are placed on the system they can be readily accommodated by adding more disks and/or workstations.

Optional plotters, printers, hard copy units and telecommunications systems are all also available. A block diagram of the system is outlined in figure C-1. A brief description of each of the elements of the system is presented on the following pages.

20. CAD system.

20.1 Hardware.

20.1.1 Central processing unit. The CPU is the heart of the CAD system, directing activity, and processing all data. Some features of the central processing unit are:

- o Virtual memory management.
- o 32-bit processing, error correcting code (ECC).
- o Architecture designed to optimize system throughput.
- o Unibus expansion backplane.
- o Bootstrap loader.
- o Standard instructions for floating and fixed point arithmetic.
- o 4 kB bipolar cache memory with parity.
- o High precision programmable real time clock.
- o Time-of-year clock with battery back-up.
- o Tape cartridge and an I/O terminal.
  (The I/O may be used as a load device for diagnostics, software updates, and as a convenient storage medium for personal data and programs.)

The CPU supports multiple interactive workstations in the foreground with no significant degradation. Plotters, tape units, and printers, can operate in the background with minimal effect on foreground input or editing at the interactive workstations.

For optimum performance and user reliability, it is suggested the CPU and disk drives be located in an environmentally acceptable area.

20.1.2 System console. The I/O terminal is a dot matrix, desk top printer terminal. It is microprocessor driven and capable of processing data at a rate of up to 45 characters per second. The operator's console provides printer controls and a typewriter-styled keyboard. Because the console is used as a direct link with the CPU for system monitoring and modification, it generally resides in the same environmentally controlled area.

APPENDIX C

THE DESIRED CED GENERIC CAD SYSTEM CONFIGURATION

10. Introduction

20. CAD system
20.1 Hardware
20.1.1 Central processing unit
20.1.2 System console
20.1.3 Disk storage unit
20.1.4 Magentic tape unit
20.2 Software
20.2.1 Operating system
20.2.2 Command processor
20.2.3 Application packages
20.2.4 Database

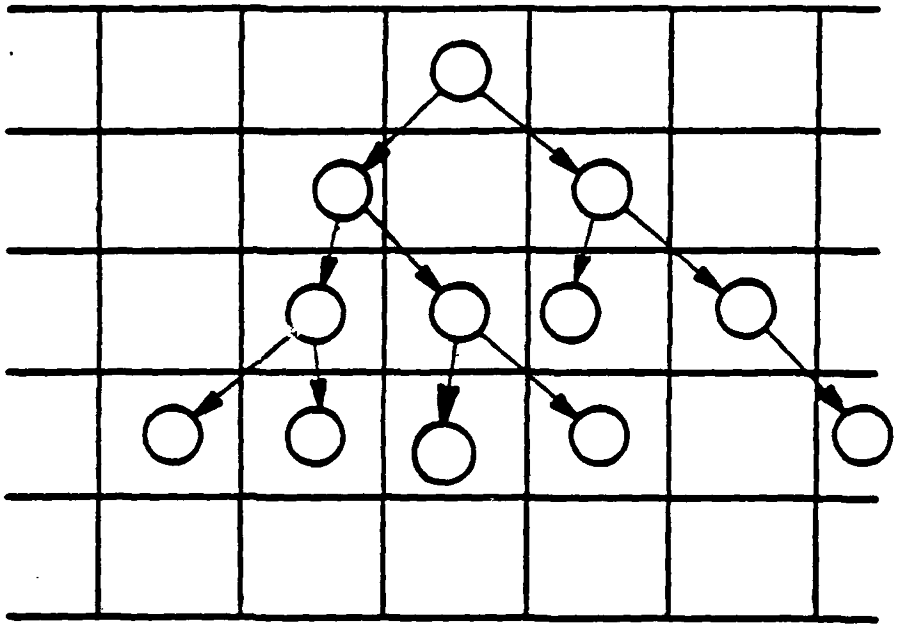
30. Design/edit workstation

40. Options
40.1 Printer
40.2 Plotter
40.2.1 Pen plotter
40.2.2 Electrostatic plotter
40.2.3 Hard copy unit
40.2.4 COM (computer output microfilm)
40.2.5 Communications

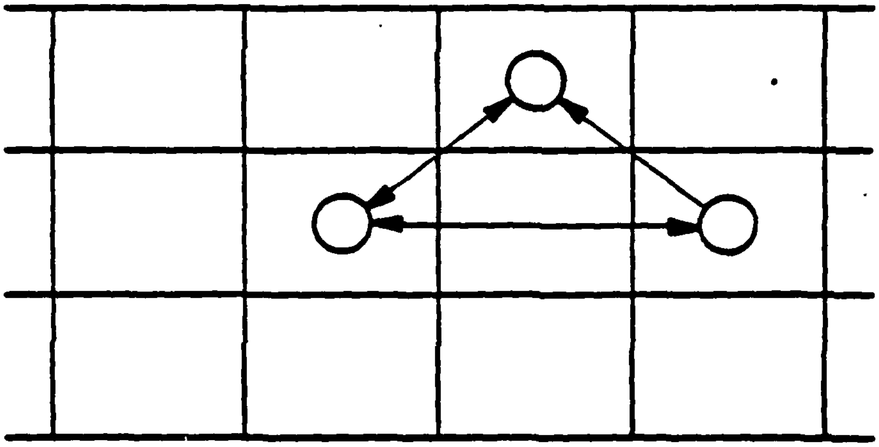
40. Conclusion.

The database is one of the most crucial segments of the software. In this software resides the flexibility to store and retrieve information in a way meaningful to the designer. This is where "data" becomes "information."

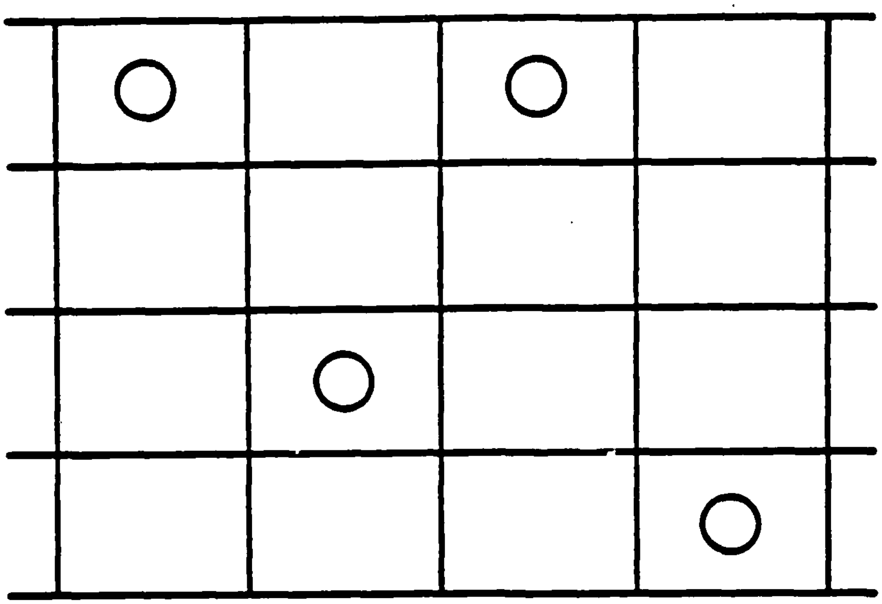
The application should dictate the data base structure used. If the wrong data base structure is selected the system response time may become very long. Some engineering applications require that extremely large amounts of data be manipulated. If the wrong data base architecture is selected some operations may well take an excessive amount of time to complete or may even be impossible to perform.



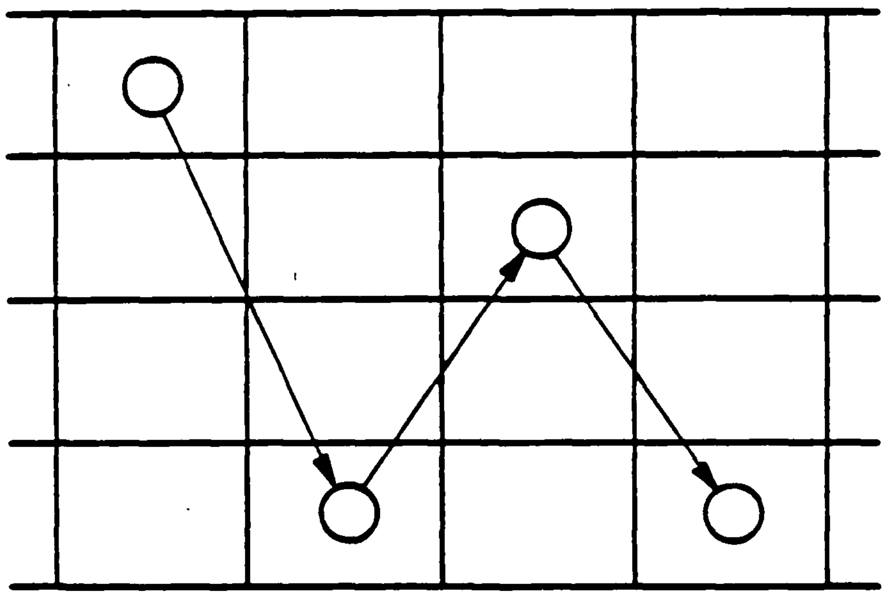
HIERARCHIAL: This form of relational database is structured in a tree form, in such a way that the data elements are related to each other in expanding connecting nodes. This form of database structure is normally found in mapping applications.



NETWORK: The network database is similar to the hierarchial database. It is relational but each element is connected to all of the others. A network database is normally used for steel structures and electrical cable runs.



HEAP: This is an unrelated database. There is no connectivity or relation between data stored. Because of the random structure, this database is usually found in simple drafting systems.



SEQUENTIAL: This form of database is related in a serial fashion. The elements are ordered sequentially so that each may have a preceeding element and a following element. This type of structure is commonly used for electrical cable runs in manufacturing plants.

Each application within the USACEEIA organization encompasses a different set of activities. This indicates that each application has a specific set of requirements for the storage and manipulation of information. This means that the information must be shaped into specific database structures, dictated by the needs of each individual discipline.

A review of frequently used CAD database structures is helpful in understanding these concepts.

30.3.3 Reports.

Various reports can be generated on a CAD system.

Examples of reports are BOM, material take-offs, sorts, counts, listings, and schedules. These reports can be automatically produced by the CAD system because it has the ability to scan through the data base and report its findings. The reports can be formatted into multiple columns of information and even contain totals at the end.

Reports can be viewed on the screen at the workstation or they can be printed on the system console, or they can be created on the high-speed printer. In addition, reports can be outputted to magnetic tape for storage purposes or telecommunicated for viewing in other areas.

30.3.4 Drawing borders.

A-size through E-size drawing borders can be used by all application packages.

The drawing borders are analogous to blank drawing sheets with standard USACEEIA text block information. Usually, the borders contain the Branch name, location information, project and scale designations.

Drawing borders are created only once; stored in the system and can be referenced many times.

30.3.5 Interface to mainframe/timeshare computer.

Many application packages utilize analysis programs which are resident on mainframe computers. Often sophisticated analysis packages are available through high-speed communications links. Through the use of the communications capabilities of a CAD system, needed information may be extracted from an application package and transferred to an analysis program resident on a mainframe computer. The results can then be returned to the CAD system where they can be interpreted by the engineers and displayed at the workstation.

30.4 Database.

A database is a collection of data.

The database is the place where the pieces of information which describe something are stored. These pieces are stored with some organizational structure in order that the selected pieces may be added or deleted.

The nature of the information, and the requirements of how one wishes to manipulate the information, dictate the way the information is stored. Aspects to be considered are the speed with which it is necessary to change information, and the manipulative requirements.

30.3.1 Symbol library.

The symbol library is where symbols are stored for use by the engineer.

A symbol library is a collection of symbols for a given applications. There are symbols for walls, cable trays, modules, relays, resistors, capacitors, etc.

The symbols in a CAD system are exactly like symbols in a manual operation, with two distinct differences:

First, a symbol is created only once in a CAD system. It is stored in a symbol library along with other symbols. When a symbol is used on a drawing, a copy is made of the one residing in the library. The symbol can be used any number of times and the symbol will be exactly the same each time.

Secondly, a symbol may have additional information stored with it. For instance, specification information or IEEE information or vendor information can be stored with the symbol for a particular type of component.

The engineer has the capability to create, modify, and delete symbols from the symbol library. Generally, modifications to the library are made only by authorized personnel so that the use of standard symbols may be enforced.

Each application package has its own symbol library which contains the symbols for that specific discipline.

A symbol library is stored collection of symbols.

30.3.2 Menus.

A menu is utilized by the user to select functions to be performed by the CAD system.

Abbreviations of or symbols representing the functions are presented in a table on the screen or tablet. The engineer selects a function by touching the appropriate place in the table or screen. This simple action automatically issues the instruction to the system, avoiding time-consuming activity with a keyboard.

In addition to functions, symbols are depicted in the menu in order that they may be chosen from a symbol library and then placed on a drawing.

Specific menus, or tables, are supplied with each application package.

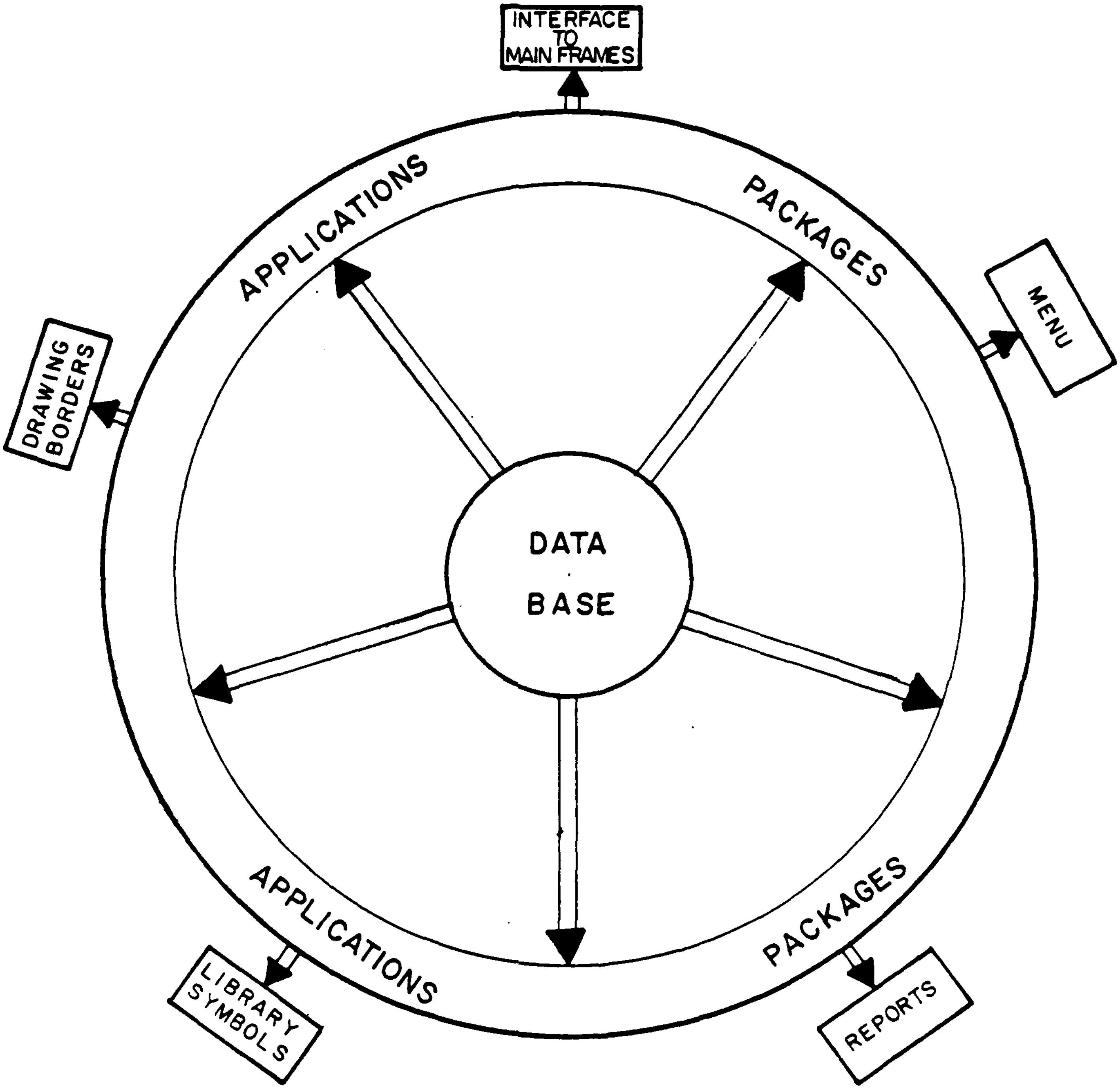


FIGURE B-3 DATABASE

Most of the functions the operating system performs are executed as a result of commands produced by the next segment of software, the Command Processor.

30.2 The Command Processor.

The Command Processor interprets functions issued by the engineer at the design/edit workstation.

The functions such as copy, rotate, move, etc. are selected from a menu on the screen or tablet at the workstation. These functions are then interpreted by the Command Processor and divided into individual commands which are transferred to the operating system level software. In many instances the functions are a long series of commands which accomplish intricate tasks. The Command Processor is capable of simplifying repetitive functions, made possible by employing local variables in the commands. For example, if the engineer wanted to create concentric circles as in a bulls eye target, the center point would be specified only ONCE for all circles, rather than once for EACH circle. Features such as this are of great benefit, and help increase the productivity of the operation.

Detailed functions are accomplished via one-button selection, made possible by the "nesting" capability of the Command Processor, a technique used for connecting a long series of commands together.

The Command Processor is highly efficient. "Fail safe" technology is built into the Command Processor, detecting potential errors and reporting them to the engineer before they occur. This a proficient "look before you leap" approach to engineering design.

The Command Processor is a highly efficient, flexible segment of software which allows the user to execute intricate, interlaced functions with the touch of one button.

30.3 Application packages.

An application package is software designed expressly for a particular application. The application package is the point of interaction between the engineer and the CAD system.

This interface is a friendly, engineering oriented environment whose functions are tailored to the activities of a specific application such as Architectural Design or Civil or Electrical Engineering.

Although many instructions are programmed for a single application, there are several elements common in all disciplines:

- Symbol libraries
- Menus
- Reports
- Drawing borders (A-size through E-size)
- Interface to mainframe computers
- Database

These elements along with representative disciplines are depicted in figure B-3.

20.10 High speed printer.

A high-speed alphanumeric printer is another option for a CAD system. The printer, usually operating at 300 lines per minute (300 LPM), is desirable for generating large reports such as bills of material, sorts, schedules, material take-offs and drawing indexes. The printer produces reports on various size paper including 8-1/2 by 11.

30. Software.

The software (sets of instructions) allows the engineer to operate the system via simplified procedures. The software is in an easy-to-understand language, enabling the engineer to comfortably execute desired CAD functions.

The software is multi-leveled pre-programmed sets of instructions which make the hardware components perform specific tasks.

The software elements are the transparent elements of the system. The software is a collection of instructions, executed in rapid succession, which control the hardware. These sets of instructions are called "programs," which are usually constructed by system personnel, called "programmers." These programs accomplish specific tasks such as draw, erase, change, move, edit, and plot a drawing on the plotter.

The software is grouped into four primary segments which are the:

a. Operating system

b. Command processor

c. Application packages

d. Database

To aid in the understanding of the software, a more detailed description of each of the four segments follows.

30.1 Operating system.

The operating system is the "closest to the hardware" segment of the software. The operating system is the data traffic manager and hardware component controller, and is resident in the CAD system at all times. It controls the input and output operations of the CAD system. The operating system is integral to every operation on the system, in one way or another. It is a multitasking monitor, which means that it can service many workstations concurrently.

The operating system controls the storage and retrieval of information from the disk storage unit and the magnetic tape unit. In addition, it delivers instructions to the plotter, which are issued by the engineer.

Security and password control are also performed by the operating system, which prevents tampering by unauthorized personnel.

20.7 Computer output microfilm (COM).

Computer output microfilm (COM) is frequently used as an output media.

COM is a process whereby the drawings are produced on microfilm for distribution and archival purposes. Drawings and documentation are written onto magnetic tape via the tape unit. The tape is then processed ("off line") producing the film. Special readers are available for viewing the drawings produced.

20.8 Remote terminal.

Remote-site workstations are sometimes desired additions to a CAD system.

A remote terminal provides access to the information and capabilities of the CAD system from long distances. Often local offices and remote field offices utilize a remote terminal.

A remote capability usually consists of an intelligent terminal with a graphics display, tablet and pen, and keyboard. Optionally, an alphanumeric monitor may be added. In some instances the remote configuration may also include a plotter.

The remote terminal is usually connected to the CAD system by telephone lines, coaxial cable, microwave link, or even satellite.

Personnel at the remote site can receive up-to-date information on engineering changes and documentation on the project. They can then review this information and effect any required changes, reducing the number of discrepancies between engineering documents and actual construction in progress.

20.9 Communications.

Communications between the CAD system and other computers is often desired for the sharing of information and access to analysis programs.

Communications between multiple CAD systems, from remote sites to the central CAD system, and other computers is accomplished with special communication equipment. Generally, this equipment consists of a modem or high-speed data link at each computer. The modems are manually connected to standard telephone lines each time for the transmission of information. In other high-speed data links, a highly sophisticated communications controller is employed to handle communications. The controller is capable of automatically connecting to other computers and properly routing the information. The communications controller is used to coordinate activities within a sophisticated network of CAD systems.

20.5 System console.

The system console is the "command center" for operators to communicate to the computer in letters and numbers only, instead of graphics tablets and pens. It can command the computer to execute various programs, as well as record messages from the computer by printing out the information. As an auxiliary use it can become an input station for excessive drawing annotation, specifications, text and tabular data, freeing up graphic workstations for other tasks. It is also useful as a low-speed printer capable of listing bills of material and other alphanumeric information.

In addition to the hardware components just discussed, there are several options available for use with the CAD system.

The OPTIONS are:

- o Plotters
- o High speed printers
- o Remote terminals
- o Communications
- o Computer output microfilm

20.6 Plotters.

The plotters are devices which are used to produce the final output of the system. Information, generally a drawing created by the engineer at the workstation, is directed through the CPU and drawing electronically on a plotter. There are several types of plotters available today for use with the CAD system.

One type of plotter is the pen plotter, which often contains more than one pen (for color) and has a width which accommodates up to E-size drawings. Typical speed for the pen plotter is 30 linear inches per second, producing a dense E-size drawing in approximately 10-15 minutes.

Another type of plotter is the electrostatic plotter, which produces black and white drawings. This plotter works on the principle of electrically charging the paper such that carbon toner adheres to the paper forming lines and text. Typical speed for the electrostatic plotter is 3 inches each second; producing an E-size drawing within minutes after command initialization.

Plotters, like disk storage units are chosen based on individual needs. In this case the determining factors are drawing resolution (picture clarity) and production speed.

The plotters are the devices which produce the final graphics product.

Features include:

- o Keyboard controls
- o Internal communication switches
- o Terminal controls
- o Terminal indicators
- o Audible indicators
- o Standard keys
- o Special function keys
- o Setup mode keys
- o 50 to 9600 baud rate transmission

20.1.3 Disk storage unit. The system provides a wide range of flexibility in system configuration. Recommended peripheral disk memory is available beginning with an 80 megabit (Mb) disk drive and expandable to 1.2 Giga bytes. Depending on system user/requirements, peripheral memory devices may be "Daisy Chained" (that is, two or more disk drives linked to the same CPU) giving the user additional storage capacity. Standard features with associated disk drives are:

- o Daisy chaining
- o Free standing
- o Proven reliability
- o Removable disk pack drive
- o Single access
- o 33.3 Msec average access time
- o 1.2 Mb peak transfer rate/sec
- o Rotational speed: 3600 rpm
- o Number of heads: 2 heads per surface

20.1.4 Magnetic tape unit. The magnetic tape unit is used primarily for generating system back-up files residing on either on or off site, archival of current and past projects, and software updates. Features include:

- o Speed 75 - 125 ips
- o Tracks - 9
- o Bits per inch - 800/1600 bpi
- o Read after write check
- o Simple, rugged design
- o Automatic error correction
- o Off-line self-diagnostics
- o Write protect sensing ring on tape transport
- o Photoelectric sensing of reflective strip

20.2 Software.

20.2.1 Operating system. The operating system is the data traffic manager and hardware component controller, and is resident in the CPU at all times. It is a multitasking monitor, which means that it can service up to 6 workstations concurrently. The operating system controls the Virtual Memory operations on the system, "swapping" information between the disk storage unit and the CPU.

20.2.2 Command Processor. The Command Processor interprets functions issued by the engineer at the design/edit workstation.

The functions such as copy, rotate, move, etc., are selected from a menu on the screen or tablet at the workstaiton. These functions are then interpreted by the Command Processor and divided into individual commands which are transferred to the operating system level software. The Command Processor is capable of simplifying repetitive functions, made possible by employing local variables in the commands.

Complex functions are accomplished via one-button selection, made possible by the "nesting" capability of the Command Processor, a technique used for connecting a long series of commands together.

20.2.3 Application packages. The first application package will accommodate the electrical discipline and associated BOM.

Menus, application programs and commands will be available to the user for efficient execution of system capabilities.

20.2.4 Database. In evaluating requirements at USACEEIA, the relational database appears to be the most flexible database for the identified requirements. Initial startup activities will require basic schematics and reports. However, as additional applications are placed on the system (dimensioned to scale drawings, cable tray runs, etc.), the selected database will be equipped to manipulate, transfer, and control the information in an optimum manner.

30. Deisgn/edit workstation.

The design/edit workstations for the system are designed for user interface ease and maximum productivity; one in color and one monochromatic. The workstations are composed of a dual screen CRT display; one for graphics and one for alphanumerics. In addition, it contains a graphics tablet and pen, workstation table, and an alphanumeric keyboard. The CRT displays, keyboards, and tablet are all easily adjustable for user convenience. The dual workstation was designed to be used for all engineering applications.

40. Options.

40.1 Printer. The optional 300-LPM line printer offers the user a significant variety of output formats, and various paper sizes. The printer may be used in an office environment giving users close proximity and quiet operation. This an important feature when multiple users are requesting a variety of reports.

Users are capable of simultaneous printer requests which are processed in the order of request. The printer operations are run in the background, resulting in smooth real time engineering capability.

40.2 Plotter.

40.2.1 Pen plotter. The drafting plotter combines quality output, high throughput, and ease of operation to give the user fast and reliable plots. Plots may be generated using liquid ink, fiber tip, and roller ball pens. ANSI A-size through E-size sheets are available using mylar, vellum, paper or polyester film mediums. Standard features include:

- o Ease of use
- o High throughput
- o Multiple pens
- o Intelligent pen control system
- o Precision control
- o Consistent velocity and acceleration

Because of its size and construction characteristics, the pen plotter may be used in many working environments.

40.2.2 Electrostatic plotter. The electrostatic plotter combines the most current features to give th user quick, accurate, and reliable plots. Maintenance and operator intervention are drastically reduced due to a minimum of moving parts. Standard features include:

- o Fast A-size through E-size drawings
- o High resolution for detailed output
- o High density data handling
- o Proven reliable operation
- o Wide variety of plotting mediums
- o Quiet operation

During operation the plotter is run in background and does not interfere with real time engineering operations.

40.2.3 Hard copy unit. The electrostatic hard copy unit gives multiple users a fast, efficient facsimile of data represented on the graphics CRT monitor. Hard copies are generally produced in 10 to 20 seconds resulting in increased productivity for workstation users. Due to its compact size, and quiet operation placement in the working environment is possible. Standard features include:

- o High resolution, 200 points per inch
- o Multifunctional printing, plotting, and hard copy output
- o Reliable operation
- o Control indicators
- o Minimum of moving parts

Typically the hard copy unit is shared among multiple users. Copies are generated in a fast real time mode giving the user an archival quality reproduction.

40.2.4 COM (computer output microfilm).

Computer output microfilm (COM) is frequently used as an output media.

COM is a process whereby the drawings are produced on microfilm for distribution and archival purposes. Drawings and documentation are written onto magnetic tape via the tape unit. The tape is then processed, producing the film. Special readers are available for viewing the drawings.

40.2.5 Communications. Communications between the CAD system and other computers is often desired for the sharing of information and access to analysis programs and mandatory for BOM creations.

Communications between multiple CAD systems, from remote sites to the central CAD system, and other computers can be accomplished with special communication equipment.

END

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